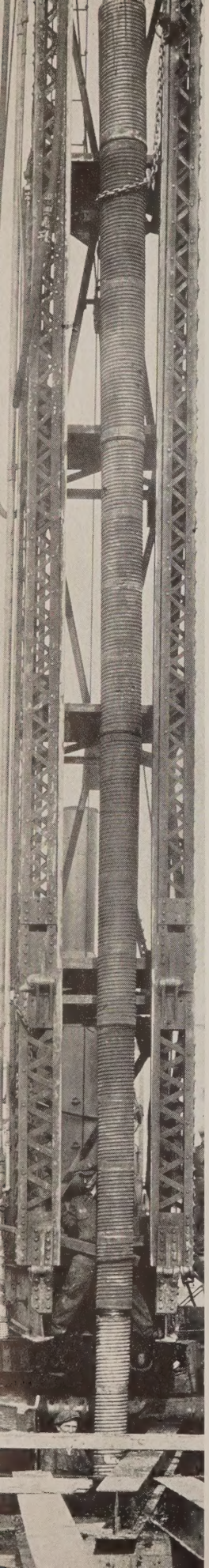
RAYMOND

Concrete Piles



A Stable Structure Must Have A Stable Foundation

The design of a building depends on the type of foundation which, in turn, depends on the load-carrying ability or bearing value of the underlying material. Raymond Service starts at the beginning and carries through to a solid substructure on which a building may be erected with confidence that it will endure.

Four Steps of Raymond Service

1 Investigation of Underground Conditions

a—Test Borings through ordinary soft grounds.—**b**—Test Borings by means of special equipment which bores through timber and other obstructions, into or through solid rock. Samples are taken for analysis, water levels noted, and reports rendered, recording all data.—**c**—Laboratory Samples: A technique has been developed for obtaining large undisturbed samples of soil for laboratory analysis so that an intelligent forecast may be made as to its behavior under a given unit load.—**d**—Test Piles—Load tests on a single pile or a group of piles when soil analysis and driving characteristics indicate the desirability thereof.

2 Interpreting the Results

Study of Data—In determining the bearing value and allowable loads, all available data is correlated and analyzed to determine the influence of each item on the result.—**The Value of Experience**—Raymond's available information includes records and tests from nearly very section of this country. 44 years spent in investigating thousands of cases, then actually driving the piles and later observing the results, have given Raymond an invaluable background of experience resulting in an unexcelled record of accuracy in determining the allowable loads and type of foundation for a particular condition.

3 Determining the Best Suited Foundation

Raymond can furnish a foundation to meet the requirements of any condition encountered. Every job is approached with an unbiased attitude and a sincere effort to recommend the type of foundation best suited structurally and economically to the client's interest. Different portions of a job may have different conditions and require different treatment. Such cases are no problem to Raymond because the varied Raymond line includes piles of sizes and types for every foundation purpose. In this catalog brief information is given as to the following standard Raymond types:

Concrete Piles, Cast-in-Place		
Standard Tapered	up to 40 ft. or more	Page 4, 6
Step Tapered	up to 100 ft. or more	Page 4, 8
Concrete Piles, Precast		Page 11
Composite Piles		
Wood lower section and concrete top	up to 100 ft. or more	Page 10
Wood Piles		Page 10
Caisson Piles		Page 11
Underpinning		Page 11

4 Installing the Foundation

Scope of Past Work—Since 1902 the "Raymond Concrete Pile" has been continuously used by the architectural and engineering professions. Today the basic Raymond idea that assures sound piles is universally accepted: "Use as a form, a steel shell that is easily inspected after driving and that is left in place to retain ground pressure developed in driving and to protect the freshly poured concrete against deformation from earth movement." Over 50 million feet of cast-in-place Raymond Piles are in worldwide use.

Experience—The data and specialized knowledge accumulated in over 44 years in this and 86 foreign countries make Raymond especially qualified to design and construct complete projects involving concrete work in addition to piling and foundations. Because of the size and complexity of most of these special projects they are not described here. A personal interview is usually necessary and we urge our clients to take advantage of Raymond's unsurpassed experience.

Personnel—Raymond representatives are available in the cities listed on the back cover. These men are familiar with construction problems and are competent to advise with architects, engineers and owners. Their engineering cooperation should be obtained from the earliest stages of a project in order that best advantage may be taken of their knowledge. Superintendents and workmen of long experience with Raymond methods and standards assure speedy and satisfactory results.

Equipment—Raymond has developed special types of land and water equipment to facilitate pile driving and construction. Units are usually located in different parts of the country and for jobs in the same section are available at a saving in time and shipping charges.

Broadly speaking, concrete piles are of two types:—**Cast-in-place**—Cast in forms previously driven to location in the ground. Largely used in building foundations and land structures.—**Pre-cast**—Cast in forms above ground, then driven like wooden piles. Largely used in docks, bridges, bulkheads and other marine structures.

Advantages

Permanency—Concrete piles, not being subject to decay or attack by wood borers and other destroying agents are, naturally, far more permanent than wood piles. Wood piles constantly saturated with water, *but not otherwise*, have long life. Water levels which may have lowered since the piles were driven bring the danger of unseen decay as happened in the two cases illustrated on this page.

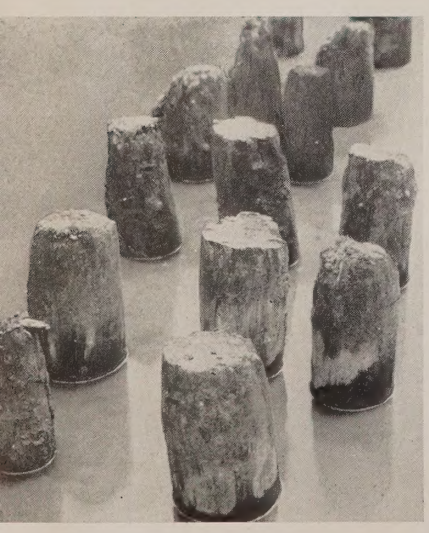
Greater Carrying Capacity—The greater carrying capacity of concrete piles arises from several factors:—**a**—Greater diameter, therefore greater displacement.—**b**—Perfect shape—of uniform size and straightness—thus insuring full ground contact and centering of the load over the point of the pile.—**c**—Possibility (with the Raymond type of pile) of inspection after driving, hence the ability to load to greater capacity, instead of making allowances for inefficiency as in the case of wood piles, which are subject to injury by over-driving, telescoping, departing from the vertical and like defects, none of which are discernable at a time when correction is possible.

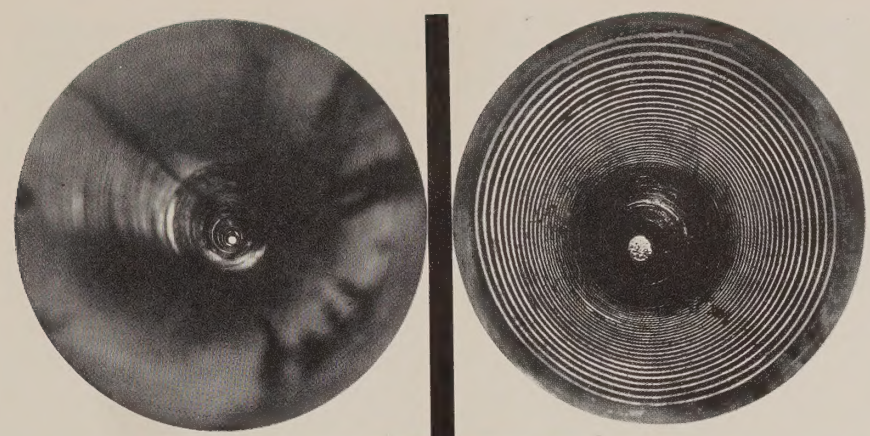
Allow Centering of Columns—All designers appreciate the advantage of keeping their column centers as near as possible to the center of gravity of the pile groups, thus reducing, and in many cases avoiding, expensive cantilevers. This is no small consideration when wide footings and limited property lines result in eccentric loads which cannot be otherwise provided for.

Save in Construction Cost—The permanency of concrete piles, regardless of moisture conditions, eliminates the deep excavation, sheeting, shoring and pumping necessary, in the case of wood piles to reach a cut-off below permanent water level. The concrete pile heads can be left at an elevation only sufficiently below the floor line to permit of the proper distribution of loads.

Save in Time—Some of the reasons for time saving with concrete piles are:—**a**—Fewer piles.—**b**—Less excavation, shoring, sheeting and pumping.—**c**—Smaller and lighter footings.—**d**—Manufacture in place from easily obtained materials.

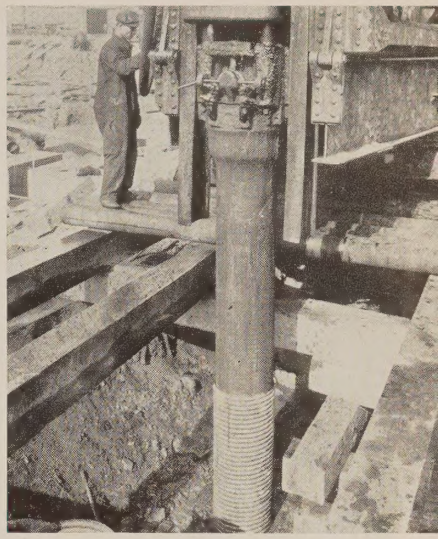
The disastrous effect of wood pile decay, following lowered water levels, is illustrated here. Settlement is sure to follow, calling for expensive repair work.

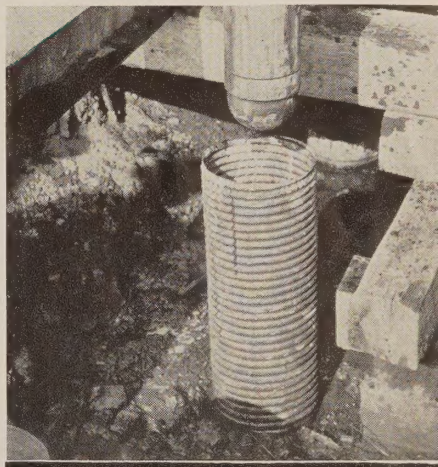




A photograph taken looking down a 70 foot Raymond Step Taper Pile. The white spot is 68 feet down.

Looking down a 25-foot Raymond Standard Taper Pile. The light spot is from water reflecting daylight.





Above: Driving a Raymond Step Taper Pile. Center: Lifting out the driving core. Below: Filling the shell with concrete.

Most Raymond concrete piles are of the cast-in-place type. The form used (or shell) is a heavy steel cylinder driven by pile hammer blows on a temporary core inserted for driving. The steel shell of a Raymond concrete pile remains permanently in the ground. This driven permanent shell is of vital advantage in properly forming piles of full load-carrying capacity; having the following advantages:

1. It serves as a form for the concrete, also prevents waste of concrete.
2. It prevents the admixture of foreign substances with the concrete, and protects it from excess of ground water during the cement setting period.
3. It retains the original moisture in the mix until the concrete is thoroughly hardened.
4. It prevents distortion by external pressure from the driving of adjacent piles or accumulated pressures from displacement by the pile itself.
5. It retains perfectly the displaced compacted earth forming the walls of the cavity, so that there may be no relaxation of the ground and, therefore, no loss of the original driving compression or of skin friction.
6. It acts as reinforcement of the pile until the concrete shall have attained its maximum strength.

It is only necessary to point out these functions of the shell to demonstrate that, in the "cast-in-place" type where no shell is used or where the concrete is placed loosely in the ground, vital safeguards are omitted—a false economy. All the points raised as to the necessity of the shell apply with equal force as arguments against its omission.

Ease of Inspecting Assures Perfectly Formed Piles

After the shell is driven and the driving core is removed, as shown at the right, it is a simple matter to inspect the condition of the shell by shining a light or lowering one into the shell. Every step can be inspected until the concrete is poured—poured into a shell known to be in good condition that will assure a perfect pile.

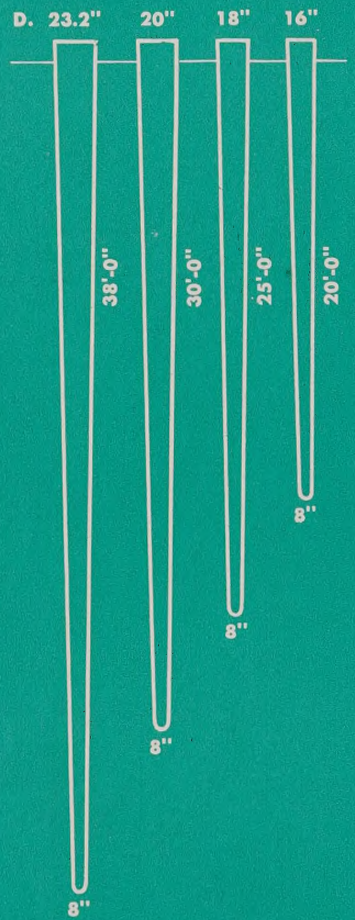
STANDARD Tapered Piles

Dimension Data

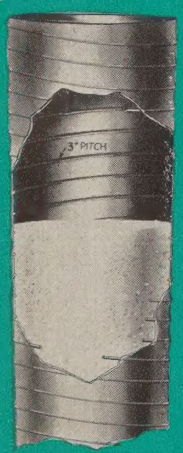
In the adjoining column are shown usual dimensions of Raymond Standard Tapered Piles.

Length Feet	Diameter in Inches Top	Diameter in Inches Point	Top Area Sq. In.
38	23.2	8.0	423
30	20.0	8.0	314
25	18.0	8.0	254
20	16.0	8.0	201

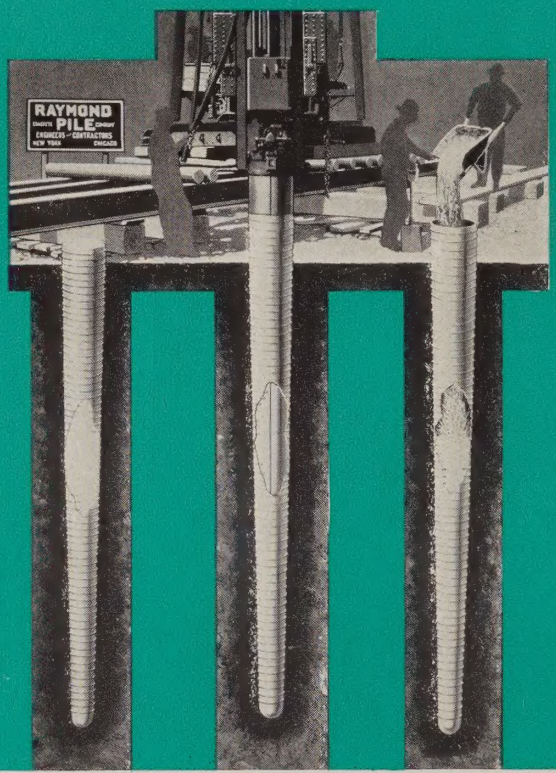
Taper 4/10-in. in diameter per lineal foot of length. The steel shell remains in the ground.



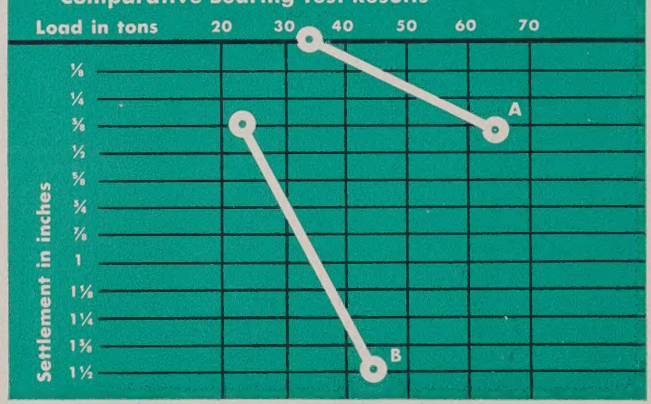
The gauge of Shell and Wire depends on soil conditions and pressures.



Installing Raymond Standard Tapered Piles



Comparative Bearing Test Results



Construction—Raymond Standard Tapered Piles have a straight continuous taper. The heavy shell is made of a tough grade of steel of thickness suitable for the length, diameter, soil conditions and pressure. This shell is internally reinforced for its entire length by a heavy, hard drawn wire spiral on a 3″ pitch. The shell and the collapsible inner core are of the same taper so that the driven core carries the shell into the ground and supports it, preventing injury or distortion during the driving process.

(Note illustration at left of page showing phantom view of shell and finished concrete).

Comparative Test of Degree of Taper—The above chart shows results of a test of two 20 ft. piles, of different taper, driven close together under uniform conditions and carefully tested one month later.

	Pile A	Pile B		Pile A	Pile B
			Settlement under load		
Point Diameter	6-in.	13-in	22-Ton Load	0-in.	3/8-in.
Top Diameter	20-in.	18-in.	35-Ton	0-in.	1-in.
Penetration	20-ft.	20-ft.	45-Ton	1/8-in.	1 1/2-in.
Hammer Blows	875	944	Load causing 3/8 in. settlement	66-Tons	22-Tons

The pile of greater taper drove easier and carried a load far in excess of the pile with larger point but less taper. This is usual experience.

Use—Measured by general use, the tapered type of pile has led all others in the concrete pile field for the past 37 years. Thousands of structures from small dwellings to mammoth industrial and commercial buildings are supported on Raymond Tapered Concrete Piles—from Canada and Newfoundland to the Republic of Argentina, and elsewhere throughout the world.

Advantages—For lengths up to about 40 feet, Raymond Standard Tapered Piles offer the advantages of ease and speed of driving, economy and high load-carrying ability.

Proven Value of the Taper—**1**—Maximum of bearing value is developed in every square inch of soil in contact throughout the pile's entire length.—**2**—Due to the tapering wedge shape, the pile cannot settle the smallest fraction of an inch without forcing lateral movement of every square inch of soil in contact with its surface.—**3**—It follows that, except for point bearing conditions, Raymond Concrete Tapered Piles assure the desired load-carrying capacity with shorter lengths than would be required if parallel-sided piles were used. Conversely, should tapered and parallel-sided piles be driven to the same length, the tapered pile will carry the greater load (see chart on opposite page), or if driven for the same load, the tapered pile would be shorter.

Comparative Cost—The failure of bidders to appreciate the greater carrying capacity of the Raymond Tapered Pile has unexpectedly increased the cost of many concrete pile foundations, contracts for which were awarded solely on the basis of the lowest price per lineal foot, without consideration of the probable length to which each type might be driven.

The purchaser who buys a pile of uniform diameter throughout its length should realize that, unless the site overlies hardpan or rock, he will have to use a much greater length than if he had bought a tapered pile.

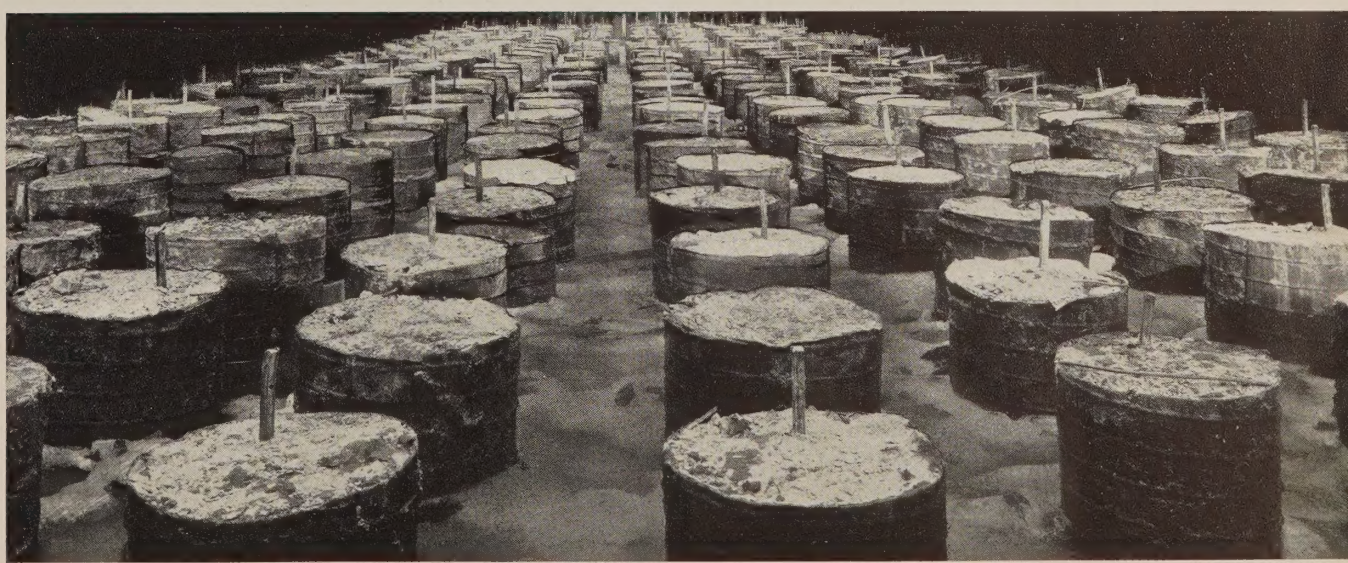
Observation of Penetration—Since in placing a Raymond pile the size and shape and the weights of the driving core and hammer are constant, and since the method of installation is such that one pile must be like another, it is possible to determine the safe load each pile can be relied upon to support. This is done by observing the penetration under each blow of the hammer, and by noting the final resistance as measured in terms of average penetration per blow for the last inch.

Constant Inspection—Attention is directed to illustrations showing the construction of the "left-in-place" shell made of steel of the proper gauge, and spirally reinforced to the degree which examination of each pile, after driving, shows to be adequate. This means inspection after every operation is completed, up to the pouring of the concrete.

Overcoming Any Defects—Should it appear, upon inspection, that a shell has been torn in driving, or should unsuspected pressures develop at some point, resulting in the entrance of water or other foreign substance, the defect can be immediately remedied by the insertion of another shell, driving it to resistance before the concrete is poured. Any distortion that may occur in a pile made without a form, or with a temporary form—any fracture that may occur in the driving of a precast pile—must of necessity remain hidden. Subsequent settlement may call attention to the existence, though not to the extent nor the nature of the concealed fault.

Driving—After excavating to the elevation to which the head of the pile is to be cut off, the tapered shell is drawn up over the tapered core, the core and shell thus forming a single driving unit. This unit is driven to the desired resistance and the core, which is collapsible, is withdrawn, leaving a clean, dry, steel-lined cavity which, after inspection, is filled with concrete to the cut-off level and the excess shell, if any, is cut off, leaving the pile ready for the footing to be poured.

A large group of Raymond Standard Tapered Concrete Piles complete and ready for footings—Note spacing, alignment and uniform grades.



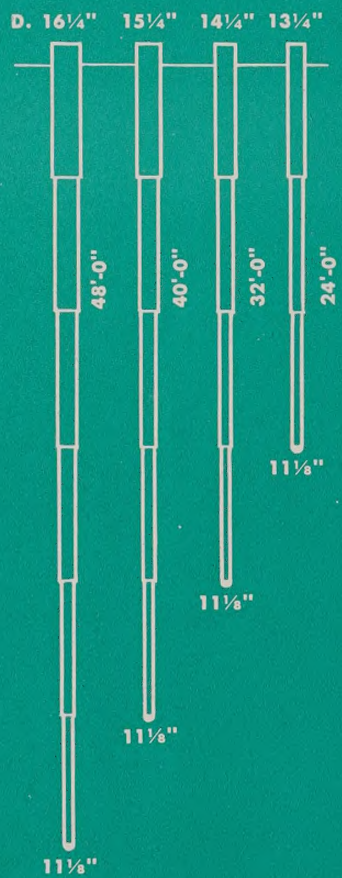
Dimension Data
The usual outside dimensions of Raymond Step Tapered Piles are as given in the adjoining column. Sections are 8 feet.

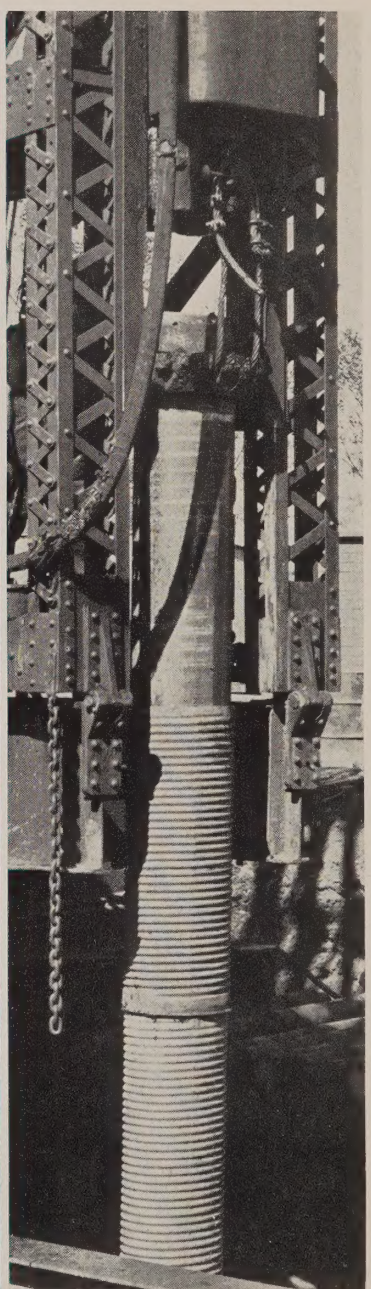
Length	Top Diameter	Point Diameter
*16 feet	12¼ inches	11⅛ inches
*24 feet	13¼ inches	11⅛ inches
*32 feet	14¼ inches	11⅛ inches
40 feet	15¼ inches	11⅛ inches
48 feet	16¼ inches	11⅛ inches
56 feet	16¼ inches	10¼ inches
64 feet	16¼ inches	9⅜ inches
72 feet	17¼ inches	9⅜ inches
80 feet	17¼ inches	9⅜ inches
88 feet	17¼ inches	9⅜ inches

Lower section of Raymond Step Tapered Pile.

Step Tapered Shell and core shoulder bearing on shell.

Greater cross sections are available if desired in the 16, 24 and 32-foot lengths — by removing the lower sections of the core and using two or more of the upper sections with driving points of corresponding size adapted thereto.





Driving the Shell

Construction—The shell is in sections, spirally corrugated to provide increased resistance to external pressures. The "steps" result from successive diameter increases from the point upward—usually 1 in. in eight feet. To the bottom of each section is welded a double flange plow ring, to the lower flange of which is welded a short spirally corrugated inner sleeve, so that each section is screw-connected to the section below. A heavy gauge hemispherical steel boot, welded to the lowest plow ring, forms the point of the shell.

The gauges of metal used ordinarily vary from No. 20 to No. 14 but are, in some instances, as heavy as No. 10 or as light as No. 24, depending on the nature of the soil to be penetrated and the pressures to be retained. Lighter sections are used nearer the surface of the ground. All seams of the shell sections are electrically welded and watertight.

The heavy walled, hollow core has a "stepped" outer surface to correspond to the steps of the shell. These "steps" which are beveled, bear directly on the beveled inner surfaces of the plow-rings of each shell section.

Use—The Raymond Step Tapered Pile was developed in 1931, for use in lengths beyond those of Standard Tapered Piles. Projects employing Raymond Step-Tapered Piles have been located in various states from coast to coast, and from Canada to the Gulf. They have included the placing, through fill and silt, rock, clay, sand and shifting soil, of as many as 12,000 piles in a single project and as few as 8, ranging in length from 16 to 100 feet or more. At La Guardia Field were driven 380,000 lin. ft. of Raymond Standard and Step Tapered Piles, chiefly in marshy or filled ground.

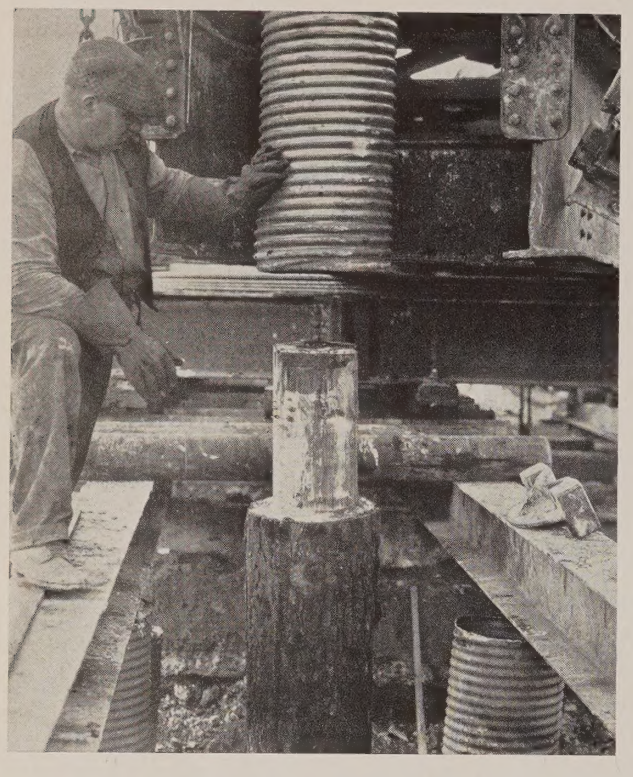
Advantages—For lengths up to about 100 feet, or over in certain cases, Raymond Step Tapered Piles provide an efficient and economical foundation where:—**1**—soil is of doubtful supporting value to a depth of 30 ft. or more, but is underlain by rock, hardpan or gravel into which the pile points may be driven,—**2**—hard soil, difficult to penetrate though unreliable because of yielding strata between it and sound footing, which must be penetrated by the piles,—**3**—alternate strata of hard and soft material which must be penetrated to reach firm bearing.

Step-Tapered Piles have the same advantages as given on page 7 for Raymond Standard Tapered Piles. On several jobs where Raymond Step-Tapered Piles were used, driving conditions were so severe that it was necessary to continue the driving to a degree of hammer resistance heretofore unknown. For instance, on one pile we have a record of driving with a 5000 lb. hammer falling 3 ft. and operating sixty blows to the minute for a period of 63 minutes and, in another instance, a total on one pile of more than 5200 blows with a No. 1 hammer to secure a penetration of about 31 ft. in order to reach rock. In both instances, upon withdrawal of the driving core, the shell was found to be undamaged and a perfect form for the concrete.

Installation—The method of driving and of cutting off is the same as described on page 7. The chief difference is, that as the shell is not carried down by friction with the core, but by contact between the step shoulders of the core and shell, the core is not required to be collapsible in order to be easily withdrawn.

A stock pile of Raymond Step Tapered Shells nested as shipped. Such nesting protects the shells and saves shipping and storage space.

Raymond Composite Piles



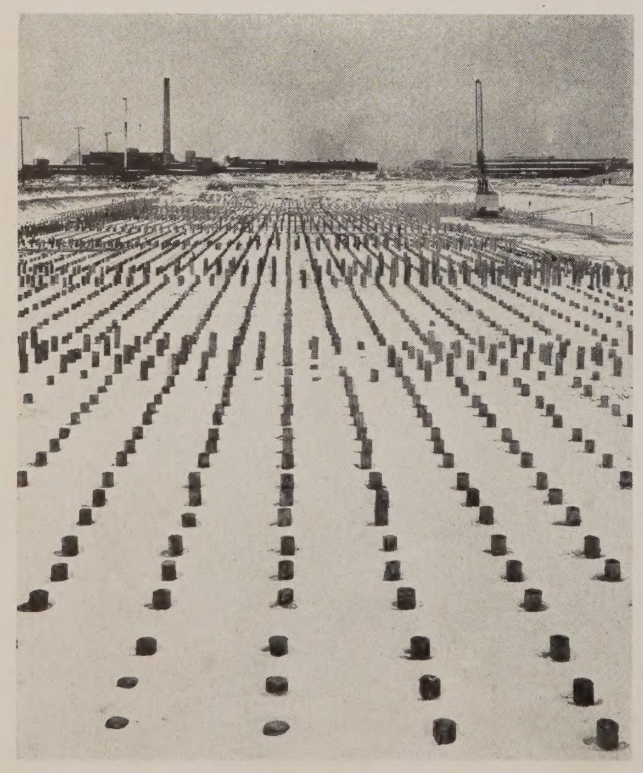
Use—For structures of certain types, where deep piling is indicated and the ground water level is shifting in nature, the composite pile (an early Raymond development), has been found to be an efficient and economical alternative to a full length concrete or wood pile.

Construction—This type of pile, as its designation implies, comprises a cast-in-place concrete pile superimposed upon a wood pile. The respective lengths of the concrete and wood sections depend on the elevation of permanent water level in relation to the ground surface, and the depth at which firm bearing may be reached. In general, the load is carried by the wood section, the concrete section acting as a column through that portion of the soil not continuously saturated. The concrete section is preferably of the cast-in-place type since its length can be varied as required to meet conditions which might develop during the driving.

Advantages—In lengths up to about 100 feet, Raymond Composite Piles when properly installed provide a secure foundation at a cost between that of wood and of concrete piles. The shell for the concrete remains permanently in the ground and provides the same protection to the concrete as outlined on pages 5 and 7.

Installation—The wood portion is driven in the usual way to approximate ground level. The shell which envelops the driving core is then lowered over the wood tenon and driving resumed and continued until the pile reaches firm bearing and the head of the wooden section is below permanent water level.

Wood Piles



Use—Wood piles can be successfully used where there is assurance of permanency of saturation and freedom from the action of subaqueous "borers" or similar deleterious conditions. Proper analysis of the factors involved may show the use of wood piles to be justified from the point of view of the expense involved to obtain a certain service for a certain time.

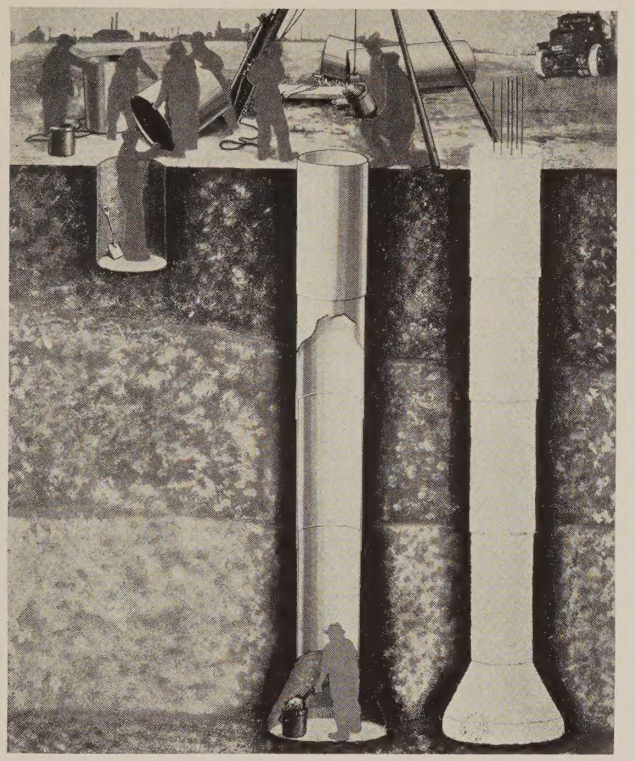
Constant saturation is easily planned for along the coast where high and low tides stay within certain limits. Also in most open country, where conditions are relatively stable, there is not much danger of a water line falling materially. For such conditions, wood piling is satisfactory.

In cities, construction of subways, sewers, etc., may reduce the water level to below the tops of piles that were formerly submerged. Where this is possible, wood piles are not recommended. The services of Raymond engineers are, of course, available to assist in deciding between wood piles and any other type.

Woods Used—Yellow pine is commonly used, except in the west; oak is frequently used in the shorter lengths; several of the western woods make good piles.

Installation—Wood piles are driven the same as other types. After driving, they should be cut off below any split or broomed portion to insure a sound pile that will carry its intended load, and, to secure any practical degree of permanence, must be cut-off below permanent water level.

Raymond Caissons



Caisson piles are not driven like other Raymond types but are made by pouring concrete into a hollow cylinder sunk into the earth.

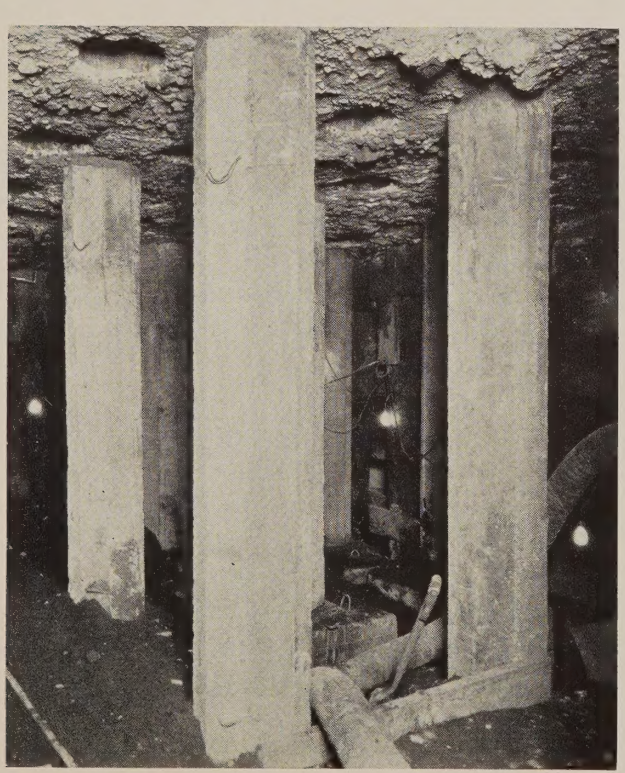
Gow Caisson Piles—A shallow pit is excavated and the top steel cylinder is driven in this pit; soil inside the cylinder is then excavated by hand. A second cylinder, about 2 in. smaller in diameter, is placed inside the first and driven, and the entire process is repeated until caisson reaches its full depth. Sometimes the lowest cylinder is driven into the final bearing stratum to seal off; in other cases a "bell" is undercut below the bottom cylinder to increase the bearing area of the caisson. When the lowest section has been filled with concrete it is withdrawn. The next cylinder is then filled and withdrawn, etc., until all are withdrawn, leaving the completed caisson in place.

When machine excavation is practicable, time can be saved with consequent economy. Re-use through salvaging the cylinders, and lack of heavy equipment make this the least expensive type of caisson.

Wet Process-Type Caissons—Installed by "Spud Drilling"—a rotary process in which the drill is assisted by high pressure water action working through the drill stem and resulting in a semi-fluid circular area of slightly more than caisson diameter. Into the area thus softened by drill and water action a steel cylinder of caisson diameter and length is driven to a seal in the hardpan—or core-drilled into the rock below—to permit of unwatering, mucking out the solids, and placing the concrete.

The process is relatively expensive but may be economically substituted for pneumatic caisson construction. More detailed information will be furnished upon request.

Raymond Underpinning



Necessity for underpinning is generally incidental to:—**a**—The protection of structures from settlement damage due to nearby operations, such as adjacent basement, sewer, or other excavations being carried to or below the elevation of the original footing.—**b**—Correcting original foundation-errors where settlement has developed due to compression of the soil.—**c**—Reinforcement of the foundation to provide for additional stories or increased loadings, sometimes because of changes in the uses of the building itself.

The type of underpinning most suitable depends upon the character of the original foundation, the design of the sub-structure, and the conditions under which the underpinning must be carried on with the least disturbance to current normal operations.

Under certain conditions, sectional piles jacked down to suitable bearing, using the original walls and footings for reaction, are the most practical and economical. In other cases, caissons are preferable. Under still other circumstances, it is desirable to carry the original footings deeper to a better subsoil bearing.

Raymond's activities include every recognized type of pile foundation, concrete, composite, precast, steel pipe and wood piles. Also borings and soil investigation, caissons and construction involving shore protection, ship building facilities, harbor and river improvements.

Raymond's recommended complete concrete pile specification will be furnished upon request.

Raymond Installations

Among the 50 million linear feet of cast-in-place Raymond Piles in some 86 countries are:

380,000 feet of Standard Taper and Step Tapered Piles at La Guardia Field, New York.

158,247 feet, 8422 Step Tapered Piles at Queensbridge Housing Project, Long Island City.

7000 Open End Piles at the Metropolitan Life Insurance Co. housing development, New York.

Offices and Representatives

New York, New York, 140 Cedar Street • Atlanta, Georgia, 57 Forsyth Street • Baltimore, Maryland, S. E. cor. Fayette and Calvert Streets • Boston, Massachusetts, 31 St. James Avenue • Chicago, Illinois, 111 W. Monroe Street • Cleveland, Ohio, 1740 E. 12th Street • Detroit, Michigan, 7430 Second Boulevard • Los Angeles, California, 311 So. Spring Street • Philadelphia, Pennsylvania, 1520 Locust Street • Pittsburgh, Pennsylvania, Cor. 4th Ave. and Wood Street • San Francisco, California, 333 Montgomery Street • Washington, D. C., 730 15th Street, N. W. • Kansas City, Missouri, 21 W. 10th Street.

W. J. Mulhall, Miami, Florida, 365 N. E. 55th Street—J. D. McCord, Milwaukee, Wisconsin, 6627 W. Garfield Avenue—R. S. Dornberger, Portland, Oregon, 6323 S. E. 31st Avenue—James Taussig, Jr., St. Louis, Missouri, 214 No. 6th Street—J. L. Wick, Seattle, Washington, 1725 W. Lake North

Raymond Concrete Pile Co., Ltd.
Montreal, Canada, 620 Cathcart Street
Toronto, Canada, 170 Bay Street

Cimentaciones y Construcciones, S.A.
Mexico City, D. F.
Avenida 16 de Septiembre Numero 5

Raymond Concrete Pile Company

Bogota	Colombia
Barranquilla	Colombia
Caracas	Venezuela
Maracaibo	Venezuela

Raymond Concrete Pile Company • 140 Cedar Street • New York